QUEENSLAND'S WET TROPICS WORLD HERITAGE AREA

MAPPING THE SCENIC QUALITY

Noah Creek — an attractive landscape eight kilometers south of Cape Tribulation.

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INTRODUCTION

In December 1988, following the nomination of the tropical rainforests of north-eastern Australia by the Australian Government, this region of Queensland was entered on the list of World Heritage sites. The area was included on the grounds that it satisfied all criteria relating to natural properties. One of these criteria involves scenic beauty.

Under the definition pertaining to scenic beauty, such areas should contain:

– natural features consisting of physical and biological formations or groups of such formations which are of outstanding universal value from the aesthetic point of view.

– natural sites or precisely delineated natural areas of outstanding universal value from the point of view of natural beauty.

The objective of this study was to produce a scenic quality map indicating the relative scenic merit of the landscapes contained within the Wet Tropics World Heritage Area of northern Queensland.

METHODOLOGY

A universally accepted scenic quality assessment procedure was not available. Many issues needed to be addressed in order to develop a methodology suitable for achieving the objective of the study. The main obstacle was the absence of a generally accepted procedure for evaluating landscape aesthetics. Moreover, the World Heritage Convention selection criteria relating to natural beauty currently provide no guidelines for conducting such assessments.

In addition, due to the limited time available for the study, it was not possible to undertake an extensive research program to test the various approaches and devise a rigorous procedure in harmony with the objective. Consequently, a strategy was developed after reviewing the literature and carefully considering the alternative methods which had already been used elsewhere. Important aspects of the chosen methodology are outlined below.

Public opinion was used to determine scenic quality. It was decided to base scenic quality assessments on the perceptions of the public rather than on the opinions of experts. Dearden (1981) concluded that techniques based on public preferences are theoretically more likely to produce better results than the judgements of landscape planners. It was also decided to restrict the survey to a representative sample of the Australian population. Although the inclusion of overseas visitors would have provided an interesting comparison, it was recognised that in practice, it would have been impossible to obtain a truly representative world viewpoint.

Photographs were used to represent the scenes. Since it would have been impractical to take a large number of survey participants to the study area, colour photographs were used to represent the broad landscapes. The strong correlation between the responses of the public to photographic representations of landscapes and on-site assessments has been demonstrated in numerous studies (e.g. Kreimer 1977, Shafer and Richards 1974, Shuttleworth 1980).

A 28 mm wide-angle lens was used, since it provided the widest viewing angle without obvious distortion. Naussaur (1983) reported that preference rankings for landscapes using either panoramic photographic or wide-angle slide sets were similar, and that both approximated the field response. He also found that a photographic format compatible with the dominant compositional orientation, horizontal or vertical, of a scenic landscape was likely to increase preference ratings. Consequently, a horizontal format was chosen to represent the broad landscape vistas.

As opportunities for panoramic views from the few roads in the study area were limited, oblique aerial photography from a helicopter provided the only feasible means of photographing the terrain at the scale of broad landscapes. Photographic framing rules were developed to ensure that the landscapes were photographed in a consistent manner. Attempts were also made to ensure that each landscape unit was photographed from a viewing position that provided the optimum scenic quality.

A scenic quality predictive model was required. As it was not feasible either to photograph or to have the participants score all of the landscapes contained within the entire 9,000 square kilometre World Heritage Area, a multiple regression model was developed. This technique has been widely used with great success in similar studies (e.g. Arthur 1977, Brown and Daniel 1984, Dearden 1980). It provided a means of determining scenic quality from measurable landscape attributes known as dimensions (e.g. topography, stream size, vegetation type), and required only a sample of the landscapes for its development.

Within-forest scenery and small-scale features were not included in the survey. Two scales of depiction (broad and foreground) were considered desirable for the appraisal of the landscape's full expression. A separate survey of the scenic quality of the vegetation beneath the forest canopy, as a foreground setting, was commenced but was not completed due to time constraints. It was also impractical to include forest foregrounds and broad landscape backgrounds in the same photograph, as this magnified problems of consistency in selecting and framing views to represent each landscape with a few photographs. Similarly, it was considered impractical to include the intimate landscape scale of foliage, flowers and epiphytes etc.

With one exception (Wallaman Falls), specific landscape features such as waterfalls, pinnacles and steep gorges were not assessed. Although such features potentially have very high aesthetic qualities, they occupied a very small area and could not constitute a broad landscape in themselves for use in the regression model. As with the within-forest scenery, it was envisaged that they should receive separate treatment in other studies, and were therefore only represented as part of the broad landscape without particular emphasis.

Area sub-divisions or landscape units needed to be defined to develop a predictive model. The partitioning of the study area into landscape units was necessary for two reasons. These were to:

— provide spatial limits for photographic sampling of the landscape; and

— enable landscape dimensions to be quantitatively determined for specific tracts of land. (These dimensions were used as the independent variables in the regression model).

The boundaries of the landscape units were determined on the basis of visual containment and dimensional homogeneity by adapting the water catchment boundaries of rivers and streams. Three-dimensional panoramic representations of the area were generated by computer, using the digital elevation modelling capability of the Queensland Forest Service's Geographic Information System (GIS). These panoramas proved invaluable for defining visually homogeneous landscape units (see Figure 1), the boundaries of which were largely based on ridge lines, coastlines and lines of major change in slope. The size of the landscape units was also constrained by the need to photographically represent each from one or a few vantage points. Eventually, 307 units having an average size of 2,900 ha were defined. Their boundaries were located on 1:100,000 topographic maps and digitised onto the study area GIS database for the subsequent generation of landscape dimensions.

PILOT STUDIES

Three pilot studies were conducted to test and refine the methodology to be used for the final survey. They were especially designed to determine the most cost-efficient public opinion assessment method. These studies were carried out using a set of 26 scenes of the Wet Tropics World Heritage Area and 12 comparison scenes from Australia and overseas of areas renowned for their natural beauty. The scenes from the wet tropics included a range of low-level oblique aerial photographs of varying forest terrain, taken specifically for the pilot studies.

Forty-eight people participated in each pilot study. The first was a householders' survey conducted by interviewing people in their own homes. Eight participants were randomly selected from each of six Brisbane suburbs across a range of socio-economic groups. The second and third were conducted at the Mt Coot-tha Botanical Gardens in Brisbane, using a random 'passers-by' approach to participant selection. In the second survey, the participants received individual attention as they scored the scenes. In the third, the participants, after receiving initial instruction, were asked to score the scenes by themselves. In all three studies, participants were selected to ensure that both sexes and a range of ages were adequately represented.

The system devised for scoring each scene was adapted from a method outlined by Robinson *et al.* (1976). Participants were initially shown two reference scenes assigned to indicate scores of 5 and 10 on a 15 point scale. As recommended by Robinson *et al.* (1976), these scenes were carefully chosen so that one was more attractive than the other but so that neither was at the extremes. The participants were then asked to assign numeric scores ranging between 1 (low scenic quality) and 15 (high scenic quality) to the 38 pilot study scenes.

The results of the pilot studies indicated that scenic quality differences did exist and that there was a high level of consistency in people's preferences for the various landscapes represented. This was an important finding, since no survey would have been required if the scenic quality of the landscapes represented did not vary. It was also found that the relative ranking of scenes within each survey did not change appreciably, indicating that it was possible to use any of the three survey methods with little effect on the final result. Consequently, the least expensive method (random passers-by, self-guided survey) was chosen.

The results also indicated that the participants had little difficulty in applying the 15 point rating scale on the score card, justifying its use together with the two reference scenes. Similarly, participants had little difficulty in scoring landscapes represented by one, two or three photographs, or in comparing overseas scenes with local scenes. Two photographs per landscape scene were subsequently used.

From the pilot studies, it was also evident that sets of photographs depicting the same landscape photographed from different positions were not significantly different. Also, no scenic preference differences due to demographic or socio-economic factors were detected. The statistical analysis of the data from the pilot studies also revealed that approximately 200 participants were needed in the major survey to provide an acceptable level of accuracy.

SAMPLING AND PHOTOGRAPHING THE LANDSCAPES

The aerial photography work for the main survey was undertaken over a two-week period in May 1989. The study area was stratified into 14 sub-regional landscape zones. A representative sample of 80 landscape units was then selected across these zones, based on terrain, adjoining land use and the presence of coastline, streams and water bodies. Likely optimum viewing points for each unit were selected using 1:100,000 topographic maps.

All photographs were taken on VPS 160 ASA colour negative film using a 35 mm camera with a 28 mm lens. The following photographic framing rules were adopted as far as possible for broad landscapes to maximise consistency in the way landscape units were represented:

— the sky was to occupy approximately one-fifth of the area of the photograph, with the longer sides horizontal;

— the horizon or background outside of the landscape unit being photographed was to be kept obscured behind ridge lines (achieved by decreasing the height of the helicopter);

— prominent peaks and rivers were to be aligned on the centre line of each photograph;

— coastline landscape units were to be

viewed from an acute angle to the shoreline (approximately 30°);
- scenes were to be photographed at a height of 30 m to 50 m above the tree canopy or water level, with the helicopter positioned above the lowest boundary of each landscape unit (i.e. shooting up valleys); and
- photographs were only to be taken between 10 a.m. and 3 p.m. with, if possible, the sun behind the camera.

During the aerial photographic mission, cloud cover and cloud shadows could not always be avoided. Up to a dozen photographs were taken for each landscape unit, from which the best two were chosen to represent each landscape unit. The first incorporated as much as possible of the unit, while the second showed a smaller section in greater detail.

SCENIC PERCEPTION SURVEY

Although the findings of the pilot studies were useful in developing the methodology used for the major survey, there were insufficient scenes to develop a regression model. The major survey, on the other hand, included a total of 90 scenes, 80 of which came from within or in the vicinity of the Wet Tropics World Heritage Area. The remaining 10 scenes were from other World Heritage areas and highly scenic areas in Australia and overseas.

The random passers-by self-guided procedure tested in the third pilot study was used together with the photographically referenced 15-point rating scale. A total of 306 Australian residents from Brisbane, Sydney, Toowoomba and Cairns were interviewed, and were asked to score each scene depending on their opinion of its attractiveness. Attention was paid to the age and gender of the participants selected, to ensure a broad cross-section of the community was sampled. Statistical outliers or participant scores which differed appreciably from average trends were eliminated to enhance the validity of the predictive equation.

The statistical analysis of the survey results indicated that landscape preference was not influenced by a participant's gender or place of residence. This confirmed the assumption that it was unnecessary to select participants from a large number of rural and urban population centres. However, the analysis also revealed that different age groups ranked certain scenes differently. Age groups above 25 years considered that human disturbance (such as clearings, roads and buildings) detracted more from an area's scenic quality than did the younger people (i.e. 18-25 years). This was quite unexpected, in that it was not indicated by the pilot study. The effect was ignored, since although it was statistically significant it was negligible for practical purposes, as only scenes having low scenic quality were affected.

PREDICTIVE MODEL

Multiple regression analysis (Weisberg, 1985) was used to develop a relationship between mean scenic quality (dependent variable) and the landscape dimensions (independent variables). In the main, the landscape dimensions used were based on those described by Zube *et al.* (1974) and Williamson and Chalmers (1982). They included binomial variables (i.e. either present or absent), multinomial variables (i.e. having three or more discrete states) and continuous variables.

Eight landscape dimensions were found to have statistically significant relationships with scenic quality. These are described below.

(1) Rivers and streams, classified as
  (i) Medium and major rivers, that were:
    - a double sided stream (i.e. as drawn on 1:100,000 topographic map) for at least 500 m within a landscape unit; or
    - a stream with a 20 km length upstream, including the length (min 500 m) within the landscape unit
  (ii) Minor or absent in all other landscape units.

(2) Coral, classified as either present or absent within coastal landscape units.

(3) Coastline, classified as either present or absent within a landscape unit.

(4) Human disturbance, classified as
  (i) Major, where:
    - greater than 10 percent of a landscape unit was cleared; or
    - a unit contained more than two kilometres of major highways and/or high voltage power transmission lines; or
    - a unit contained occupied buildings.
  (ii) Minor, where:
    - less than 10 percent of a landscape unit was cleared; or
    - a unit contained less than two kilometres of highways and/or high voltage power transmission lines.
  (iii) Nil for all other units.

(5) Boundary interference, classified as
  (i) Major, where:
    - more than 10 percent of the perimeter of a landscape unit was within or adjacent to cleared land; or
    - buildings were present immediately adjacent to the unit.
  (ii) Nil or minor for all other units.

(6) Water bodies (lakes or dams), classified as either present or absent in a landscape unit.

(7) Vegetation type 1, classified as the percentage of a landscape unit comprised of mesophyll and notophyll vine forest types as defined by Tracey and Webb (1975). (Other forest types were found to be not significant).

(8) Slope class 3, classified as the percentage of a landscape unit comprised of land with a 25° to 40° slope. (Other slope classes were found to be not significant).

Parameter estimates for the landscape dimensions which were included in the final regression model, together with their standard errors and t-values, are given in Table 1. Human disturbance and boundary interference, which had negative signs, reduced the scenic quality of the landscapes. The presence of large rivers, coral, coastline, water bodies, vegetation type 1 and slope class 3, which all had positive signs, enhanced scenic quality.

A number of landscape dimensions based on topography were tested, but found to be not significantly related to scenic quality. Similarly, the presence of rocky coastlines, gorges, waterfalls or pinnacles were found to have no significant effect on scenic quality at the scale of broad landscapes.

The regression relationship explained almost 85 percent of the variation in scenic quality scores (i.e. Coefficient of Determination = 0.845). This compares very favourably with other landscape scenic quality models (e.g. Arthur 1977, Dearden 1980, Brown and Daniel 1984).

An examination of the residuals (i.e. observed minus predicted scenic quality) indicated that the model reduced photo-quality effects such as the presence of clouds, varying depth of view, or any inconsistency in the photographic representation of a landscape unit. Thus, in these cases it appeared that the model was a more accurate predictor of the aesthetic quality of a landscape unit than the participants' response to the photographic representation of that landscape.

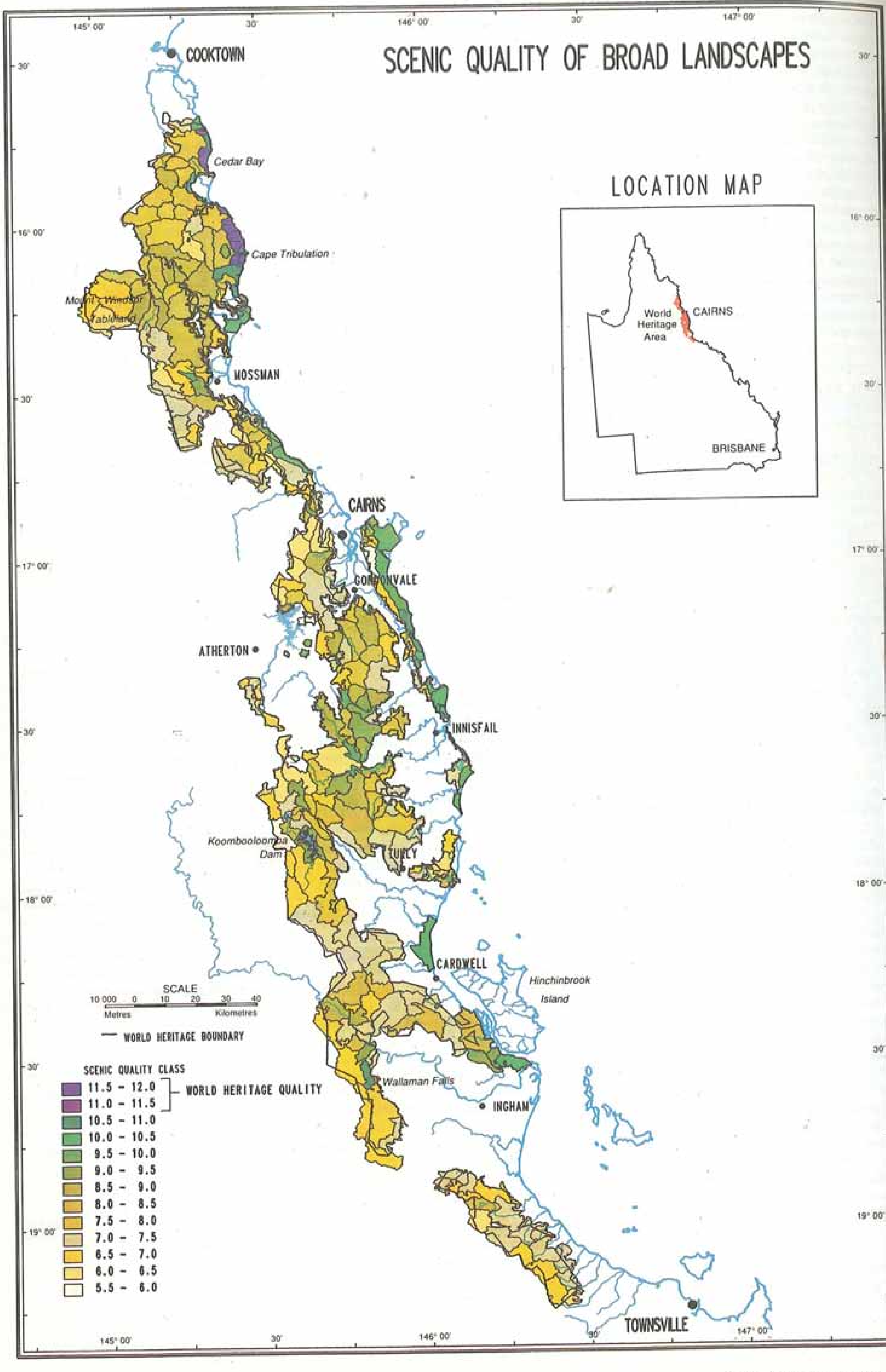
DETERMINATION OF WORLD HERITAGE SCENIC QUALITY

Kakadu was the lowest scoring (11.45) World Heritage comparison scene. Consequently, its mean score minus twice the standard error (0.22) was chosen as the cut-off point for World Heritage scenic quality determination for landscapes within the Wet Tropics World Heritage Area of Queensland. ►

Table 1. Parameter estimates, standard errors and t-values for the dimensions included in the regression model.

Variable	Parameter estimate	Standard error	t-value	Sig. level
Constant	6.922	0.1629	42.49	***
River (i)	+1.075	0.1878	5.72	***
Coral (present)	+1.281	0.4178	3.07	**
Coastline (present)	+2.617	0.2271	11.52	***
Major Human Disturbance (i)	−1.334	0.3600	3.71	***
Minor Human Disturbance (ii)	−0.6738	0.2077	3.22	**
Boundary Interference (i)	−0.5817	0.2654	2.19	*
Water Bodies (present)	+2.112	0.4688	4.51	***
% Vegetation Type 1	×0.01203	0.002995	4.02	***
% Slope Class 3	×0.02451	0.007688	3.19	**

*$P<0.05$, **$P<0.01$, ***$P<0.001$



SCENIC QUALITY OF BROAD LANDSCAPES
LOCATION MAP
World Heritage Area
CAIRNS
BRISBANE
COOKTOWN
Cedar Bay
Cape Tribulation
Mount Windsor Tableland
MOSSMAN
CAIRNS
GORDONVALE
ATHERTON
INNISFAIL
Koombooloomba Dam
TULLY
CARDWELL
Hinchinbrook Island
Wallaman Falls
INGHAM
TOWNSVILLE
145° 00'
30'
146° 00'
147° 00'
16° 00'
17° 00'
18° 00'
19° 00'
SCALE
10 000 0 10 20 30 40
Metres
Kilometres
WORLD HERITAGE BOUNDARY
SCENIC QUALITY CLASS
11.5 - 12.0
11.0 - 11.5
WORLD HERITAGE QUALITY
10.5 - 11.0
10.0 - 10.5
9.5 - 10.0
9.0 - 9.5
8.5 - 9.0
8.0 - 8.5
7.5 - 8.0
7.0 - 7.5
6.5 - 7.0
6.0 - 6.5
5.5 - 6.0

Mount Windsor Tableland — This landscape received a relatively low scenic quality score.

Areas surrounding Cape Tribulation rated highly.

Wallaman Falls — This is the highest single drop waterfall in Australia and one of the most attractive features within the World Heritage Area.

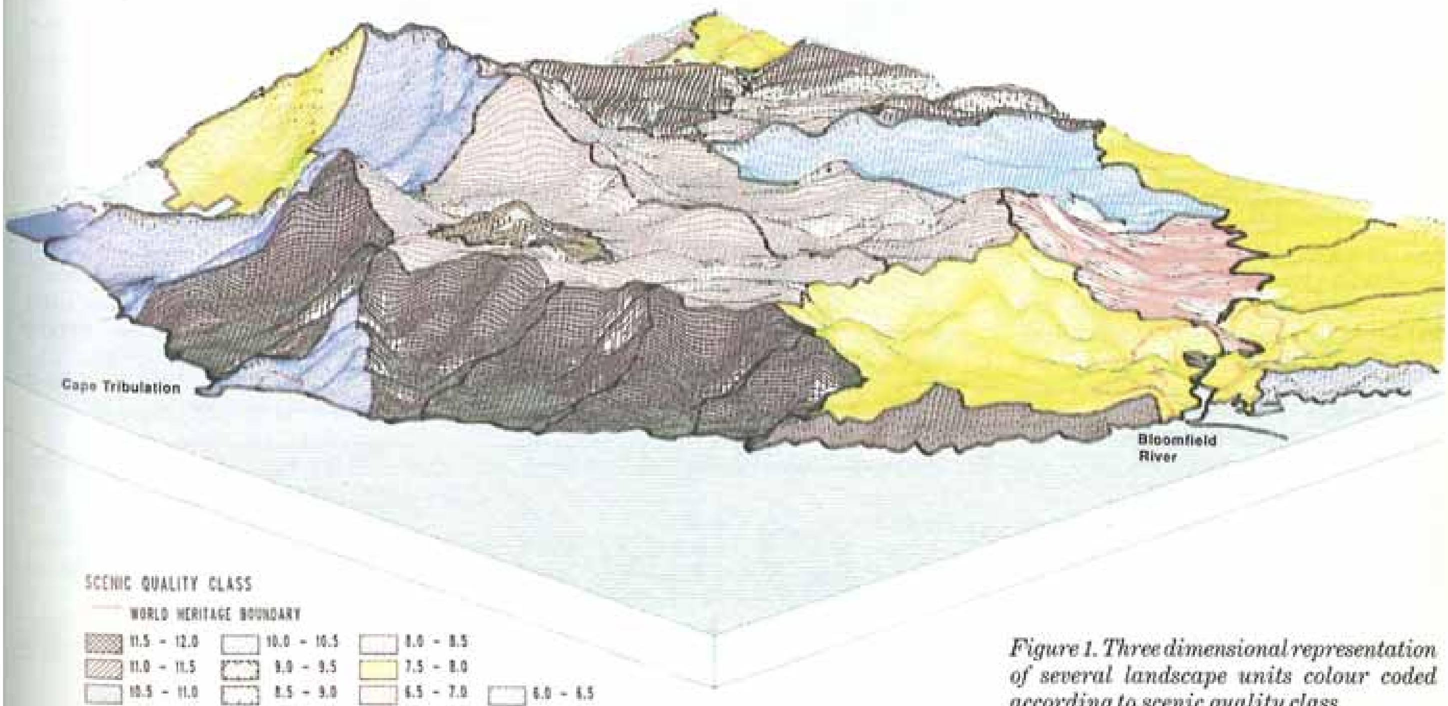


Figure 1. Three dimensional representation of several landscape units colour coded according to scenic quality class.

Using this cut-off point, only 9 out of 307 landscape units within the study area were deemed to be of World Heritage scenic quality. All 9 were located in heavily forested mountainous terrain bordering the coast in the Cape Tribulation and Cedar Bay vicinities. Figure 1 depicts some of these landscape units in a three-dimensional panoramic format. Wallaman Falls was tested as a feature in the survey and received a score well above this standard, indicating that other features in the area could also have relatively high scenic qualities.

Considerable difficulty was experienced in obtaining sufficient comparative World Heritage Area photographs, especially in the format required. Consequently, the cut-off point nominated should not be regarded as absolute and should undergo further refinement if additional comparative scenes could be obtained. However, having scenic quality scores for each landscape unit is of considerable benefit if an alternative cut-off point were to be applied, for World Heritage classification or other purposes.

USEFULNESS OF STUDY

This study demonstrated that it is possible to determine scenic quality objectively. The major requirements for achieving objectivity in this study were:

- delineation of scenic units largely based on natural boundaries;
- determination of optimal aerial viewing points as a common reference for photographing each landscape unit;
- development of a 15-point score card containing two carefully chosen reference scenes, which could be used to assist the participants in scoring each scene; and
- development of a regression model, in which landscape dimensions were used to predict the scenic quality score of each unit.

There are three major benefits of this study.

The first concerns the application of the scenic quality map to the management of the Wet Tropics World Heritage Area. A broad-landscape scenic quality map would be of assistance in many land use planning decisions (see Figure 2). The map may also serve as an inventory overlay in the generation of land use zoning plans, where each area has a range of values and potential uses. Objective and comprehensive detail on scenic quality would mean its importance in land use planning need not be downgraded or ignored. Where roads, power transmission lines or other utilities are required, and would enter or cross the World Heritage Area, the scenic quality map could assist in the evaluation of alternative routes. The predictive model could also indicate the degree of loss in scenic quality associated with major developments affecting the forest canopy. Walking tracks and other recreational facilities could be sited to maximum benefit based on a knowledge of the relative attractiveness of different areas. While the broad landscape scenic quality map is important for such applications, the completion of maps incorporating foreground vegetation and features would be equally useful.

Cedar Bay — With its coral reef, clear sandy beach, lush vegetation and sloping terrain, this scene received a very high scenic quality score.

The second benefit concerns the development of a methodology capable of distinguishing areas of World Heritage significance from the aesthetic point of view. It is suggested that World Heritage Area nominations in future be required to meet more objective minimum scenic quality standards based on scenic perception studies which include photographic references of established World Heritage Areas. This should apply particularly to those areas where the criterion of outstanding universal value based on outstanding natural beauty figures prominently. Written criteria are inadequate as they are too open to individual interpretation. The lessons learnt from this study provide a basis for developing photographic sampling and scenic perception survey procedures applicable to future World Heritage Area nominations. Further work is required to establish a more accurate and reliable cut-off point or points. For this purpose, it is suggested that photographic scenic quality standards should be established within a framework of world-wide landscape thematic types.

The third benefit concerns the application of the procedures developed here to mapping the scenic quality of other natural resource areas. This scenic quality model is not recommended for general use elsewhere, except where the same range of landscape dimensions occur and similar relationships could be expected. Nevertheless, it is hoped that this work will stimulate further studies of this type for other areas.

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